Voltage Tunable Two-color Superlattice Infrared Photodetectors

by **J. L. Reno**

Motivation—Voltage tunable two-color infrared detectors have many important applications such as remote temperature sensing and chemical analysis. It is particularly useful to have two-color detectors that respond in the 3−5 μm midwavelength infrared (MWIR) and the 8−12 μm long-wavelength infrared (LWIR) ranges, which are atmospheric transmission windows. Quantum well infrared photodetectors (QWIPs) with voltage tunable peaks are attractive for two-color detection because these two-terminal devices, when integrated with time-multiplexed readout circuits, greatly simplify the production of high-uniformity focal plane arrays (FPAs).

Accomplishment—We have demonstrated voltage tunable two-color superlattice (SL) detectors, where the peak wavelength switches from the LWIR to the MWIR range upon reversing the polarity of applied bias. The active region of these superlattice infrared photodetectors (SLIPs) consists of multiple periods of two short-period SLs designed for MWIR and LWIR detection. These SLIPs rely on two types of blocking layers to achieve voltage tunable operation: a thick undoped barrier for low-energy dark electrons and a thick doped layer for high-energy photoelectrons. The first detector, which consists of AlGaAs/GaAs SLs for both LWIR and MWIR detection, demonstrates wavelength switching from 9.5 μm under large positive bias to 6 μm under negative bias and has a background-limited temperature of 55 K for 9.5 μm detection and 80 K for 6 μm detection. The second detector (results shown in the figures), which contains AlGaAs/GaAs SLs for LWIR detection and strained InGaAs/GaAs/AlGaAs SLs for MWIR detection, exhibits wavelength switching from the 8−12 μm band under positive bias to the 3−5 μm band under negative bias. The background-limited temperature of this detector is 70 K for LWIR detection and 110 K for MWIR detection. This SLIP is the first ever voltage tunable MWIR/LWIR detector with performance comparable to those of optimized one-color QWIPs. We have also demonstrated that corrugated-QWIPs are capable of coupling normally incident light for two-color application.

Significance—Using different SL pairs, one can obtain different two-color combinations with bandwidths tailored to suit specific applications, which indicates the usefulness of our design for large-format FPAs.

Sponsors for various phases of this work include: Nuclear Weapons/Science & Technology

Contact: John L. Reno, Semiconductor Material & Device Sciences, Dept. 1123
Phone: (505) 844-9677, Fax: (505) 844-3211, E-mail: jlreno@sandia.gov

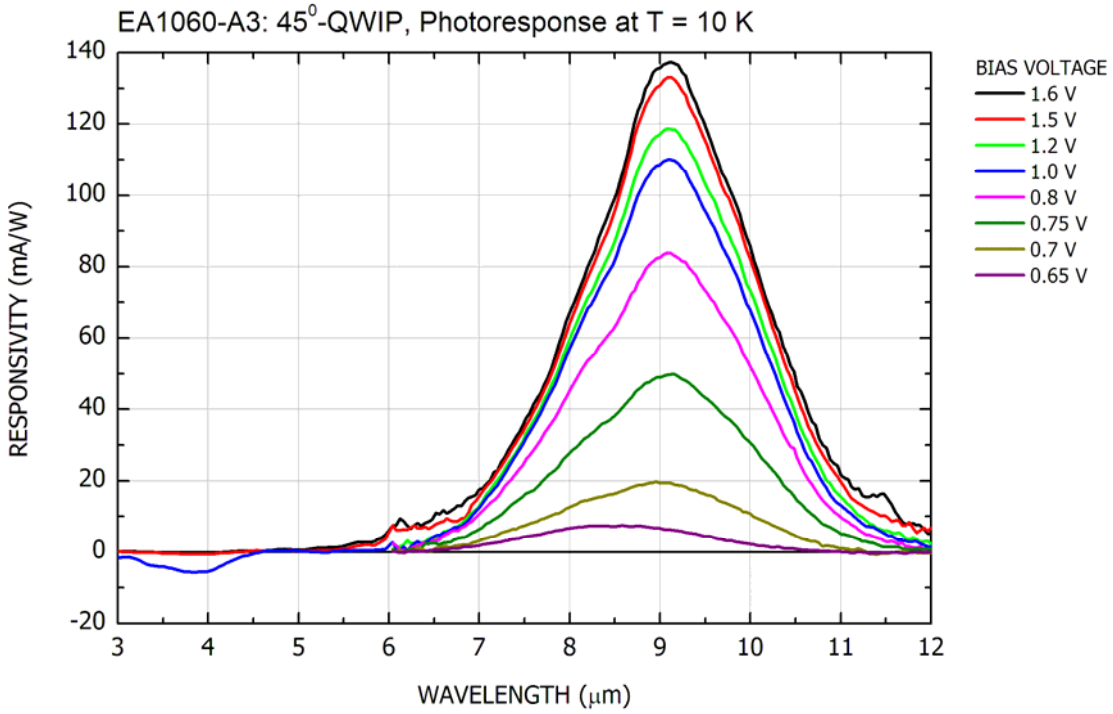

Figure 1. Responsivity in the LWIR under positive bias voltage.

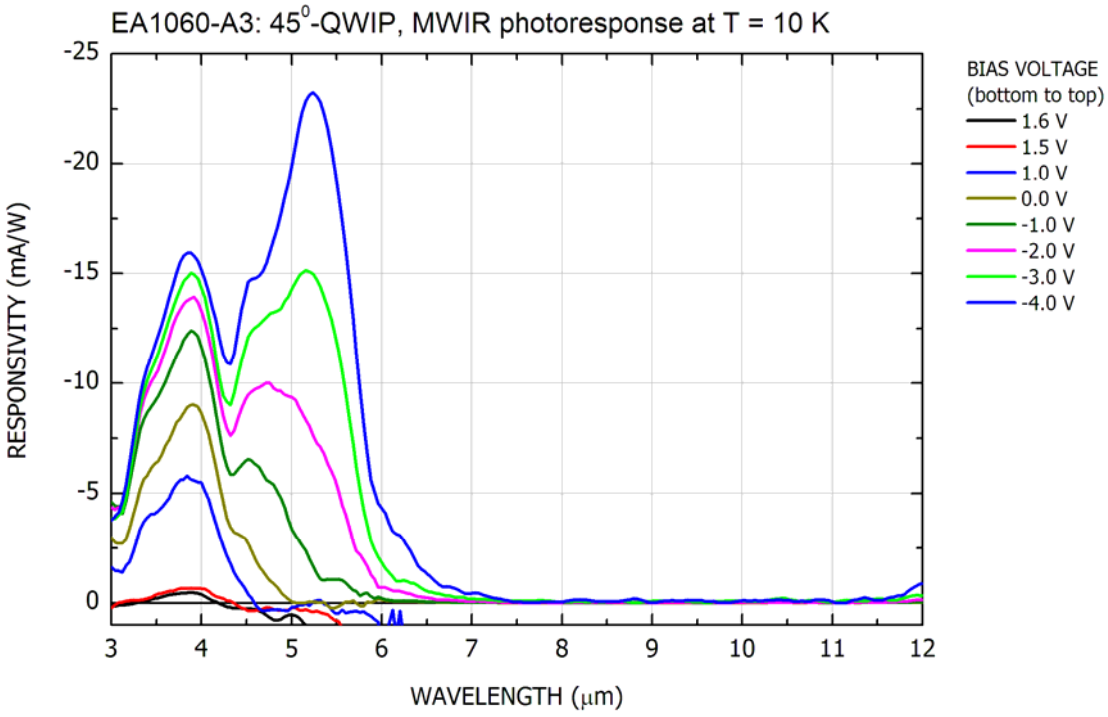

Figure 2. Responsivity in the MWIR under negative bias voltage.